

REMARKS

Favorable reconsideration and allowance of this application are requested.

By way of the amendment instructions above, claim 1 has been revised so as to include therein the substance of original claims 10 and 11. The latter claims have thus been cancelled as redundant in view of the amendments made to claim 1.

The objected to phraseology "-series" has been deleted from claims 5 and 12.

Applicants respectfully request reconsideration of the alleged indefiniteness with respect to the phraseology "derivative". Specifically, applicants note that the term "derivative" is conventional and well known in the technical field to which the present invention pertains. Additionally, each claimed derivative is clearly defined in the originally filed specification. For example, the derivative in claims 6 and 7 is defined on page 27, line 29 to page 28, line 1 and page 29, lines 8-13. The derivatives of claim 12 are defined on page 65, line 14 to page 71, line 25. page 72, line 12 to page 75, line 4. Moreover, an inhibitor for inhibiting the formation of a phosphoric acid derivative in claim 15 is also defined on page 88, lines 11-19 and page 88, line 23 to page 89, line 3.

In view of the amendments and remarks above, therefore, applicants suggest that all claims now pending in this application satisfy all requirements of 35 USC §112, second paragraph.

As will become clear from the discussion which follows, the claims pending herein are likewise patentably distinguishable over the applied references of record.

I. Novelty and unobviousness of the present invention

1. The Applied References

(a) Amann (USP 4,230,606)

Amann discloses a molding composition comprising a polyoxymethylene, a melamine formaldehyde polycondensate as thermal stabilizer and an antioxidation agent wherein said melamine formaldehyde polycondensate is a finely divided, cross-linked substantially water insoluble polycondensate which is the precipitation product obtained by reacting formaldehyde, melamine and at least one other substance that can react to form a part of said polycondensate. The polycondensate is present in an amount of 0.001 to 30 wt.% related to the total weight of said composition, said polyoxymethylene has a crystallite melting point of 140⁰C to 180⁰C, a density of 138 to 1.45 g/ml, and a viscosity of at least 30 ml/g at 135⁰C with a solution of 0.5g polyoxymethylene in 100 ml dimethylformamide containing 2 wt% diphenylamine. The disclosed polycondensate has a primary particle size less than 1 μ m, and a specific surface up to 250 m²/g (claim 1). The polyoxymethylene may be a homopolymer of formaldehyde, a homopolymer of trioxane or a copolymer of trioxane, and 0.01 to 20 wt% of at least one compound copolymerizable with trioxane (claim 11), or a copolymer of trioxane and 1,3-dioxepane (claim 13).

The precipitation polycondensate causes a considerable improvement in the thermal stability of polyoxymethylene when employed in combination with antioxidants (column 1, lines 54-59). Amman discloses that the molding materials must contain an antioxidation agent in order to protect against the harmful influence of oxygen in the atmosphere, especially at elevated temperatures. Preferably, phenolic antioxidation agents are employed and especially compounds having 2 to 6 hydroxyphenyl radicals in the molecule (column 6. lines 7-13).

The molding material of Amann can also contain customary amounts of other additives conventionally employed in polyoxymethylene molding materials (column 7,

lines 11-13). Specific examples include other heat stabilizers, such as carboxylic acid amides (e.g., malonic acid, terephthalic acid diamide) and difficultly volatile 5-triazine derivative (e.g., melam, melem, melon); UV absorbers and light protective agents; fillers and/or reinforcing substances in a powdery, fibrous, flaky or other suitable form from metals, glass, carbon, organic polymers (e.g., cellulose, polyoxanones, polyesters, polyurethanes); lubricants; auxiliary processing agents (e.g., fatty acid amides); nucleating agents; pigments or dyes; acid acceptors (e.g., polynuclear aromatic amines); fire-retardant substances (red phosphorus) (column 7, lines 14-45).

(b) Abolins (USP 4,242,254)

Abolins discloses a composition (molding powder) comprising particles of resin having dispersed therein a reinforcement comprising filamentous glass in which the filamentous of said glass are uniformly coated with a non-burning or self-extinguishing polymerized sizing composition that consists essentially of a thermoplastic or thermosetting resin, a silane or chrome coupling agent and a flame retardant additive, said flame retardant additive being present in an amount that is sufficient to render the composition non-burning or self-extinguishing (claim 1). The resin may be non-burning or self-extinguishing (claim 3) and may be a styrene resin, a polyolefin resin, a polyamide resin, a polyacetal resin, a polycarbonate resin, or a mixture thereof (claim 5). The flame retardant additive may be a halogen-containing compound; elemental phosphorus or a phosphorus compound; or a compound containing phosphorus-nitrogen bonds (claim 29). The sizing composition may include a chlorinated biphenyl (claim 30).

The sizing agent may consist of a thermoplastic or thermosetting resin selected from the group consisting of a styrene resin, an alkyl resin, an acrylate resin, a methacrylate resin, an aromatic polycarbonate resin, a polyacetal resin, a polyamide resin, a vinyl ester resin, polyphenylene oxide resin or a mixture thereof and a flame

retardant additive in an amount sufficient to render the resin non-burning or self-extinguishing (claim 33).

The amount of flame-retardant additive used in Abolins is not critical, so long as it is at least sufficient to render the resin non-burning or self-extinguishing (column 4, lines 12-14). In general, amount of the additive will be from 0.5 to 50 parts by weight per 100 parts by weight of resin (column 4, lines 21-23). Elemental phosphorus will be preferred at 0.5 to 2.0 parts by weight per 100 parts of resin, while phosphorus in the form of triphenyl phosphate will be used at 25 parts of phosphate per part of resin (column 4, lines 34-38). In general, the preferred phosphate compounds are selected from elemental phosphorus or organic phosphonic acids, phosphonates, phosphinates, phosphonites, phosphinites, phosphene oxides, phosphenes, phosphinites or phosphates (column 6, lines 44-48). Moreover, the typical examples of phosphates are disclosed on column 6, line 62 to column 7, line 8. The sizing can comprise a thermoplastic or thermosetting resin and a flame-retardant additive in an amount from 0.5 to 50 parts by weight per 100 parts of resin, at least sufficient to render the sizing non-burning or self-extinguishing (column 9, lines 54-58).

In the Example 7 of Abolins, glass fibers containing 1.2 wt% of a thermoplastic styrene ethyl acrylate copolymer sizing material were treated with a chlorinated biphenyl and the resulting reinforcement is compounded with a various resin such as polyacetal.

Moreover, in Example 8, glass fibers containing 1.2 wt% of a thermoplastic styrene ethyl acrylate copolymer sizing material were treated with various flame-retardant additives such as elemental red phosphorus. triphenyl phosphate, diphenyl phosphonate and resulting reinforcement is compounded with a resin composition comprising polyphenylene oxide resin and polystyrene resin.

With respect to the effect of the formulations, Abolins discloses that because of their excellent physical, mechanical, chemical, electrical and thermal properties and

their enhanced flame resistance, the resin-glass composites have many and varied uses (column 17, lines 1-4).

(c) Doyama (USP 5,236,988)

Doyama discloses an engineering plastic composition comprising an engineering plastic material and an aliphatic polyester, wherein said aliphatic polyester is produced from a monomer component containing:

- (i) at least one member selected from the group consisting of an aliphatic dicarboxylic acid of formula I, lower esters and halides thereof;
- (ii) an aliphatic diol: and
- (iii) at least one member selected from the group consisting of a dihydroxy compound of formula II and acetylides thereof, and
- (iv) a mixing ratio of said aliphatic polyester in said engineering plastic composition being in the range of 1 to 50% by weight (claim 1).

The engineering plastic material may be at least one selected from the group consisting of polyetherimide, polyarylketone, aromatic polysulfone resin, polyarylenesulfide, polyarylate, saturated polyester, polyamide-imide, polycarbonate, polyphenyleneoxide, polyamide, and polyorymethylen (claim 2).

Doyama discloses in the Description of the Prior Art, that there is a strong need for a polyoxymethylene composition with low melt viscosity, that is, excellent workability, excellent moldability, and high impact strength (column 5, lines 56-59).

Doyama also discloses that in order to obtain an engineering plastic composition with excellent heat stability and rubber-like elasticity, the mixing ratio of the aforementioned polyester is in the range of 50 to 99% by weight (column 20, lines 13-16) and that if the amount added exceeds 99% by weight, the heat stability of the aliphatic polyester is not improved (column 20, lines 19-21).

It is also possible to include additives in the engineering plastic composition of Doyama, for example, inorganic fillers: heat stabilizers such as triphenylphosphite, trilaurylphosphite; flame retardants such as hexabromocyclododecane, tris- (2, 3-dichloropropyl) phosphate; UV absorbers; antioxidants, and antistatic agents (column 20, lines 49-65).

(d) Yoshitani (USP 5,314,912)

Yoshitani discloses a method of improving the sliding property of a thermoplastic resin selected from the group consisting of a polyoxymethylene resin, a polycarbonate resin, a styrene resin, a polyester resin, a polyarylene sulfide resin, a polyamide resin, a polyphenylene ether resin, a polyarylate resin and mixtures thereof, said method comprising the steps of adding 0.1-50% by weight of a lubricating material and 0.1-50% by weight of sliding property improving agent, said agent comprising a multiphase structure thermoplastic resin made of a graft copolymer which consists of an ethylene polymer (a) and a vinyl polymer (b) formed from a monomer selected from the group consisting of an aromatic vinyl monomer, an acrylic acid ester monomer, a methacrylic acid ester monomer, a vinyl cyanide monomer, a vinyl ester monomer and mixtures thereof, said vinyl polymer (b) having a mean number degree of polymerization of from 10 to 5,000, one of ethylene polymer (a) and vinyl polymer (b) being a dispersing polymer(claim 1). The lubricating material may be selected from the group consisting of fatty acids, alcohols, fatty acid esters, silicones, mineral oils and mixtures thereof (claim 2).

With respect to the additives, Yoshitani discloses that it is also possible to add additives described below to the system which may also be similar to those employed in the present invention (column, lines 39-40). As the additives, Yoshitani discloses organic fire retardant such as fire retardants containing halogen and phosphorus (column 11, lines 44-46) and engineering plastics such as, polyolef in resins, polyoxymethylene resins, polyamide resins, polyester resins, polycarbonate resins, ABS

resins, polyphenylene sulfide resins, polyarylate resins and fluorine-contained polymers (column 11, lines 64-68).

Yoshitani discloses that the multi-phase structure thermoplastic resin functions as a perfect sliding property improving agent (column 18, lines 32-35). It is also found that a combination use of said multi-phase structure thermoplastic as a sliding property improving agent and lubricating material exhibits, a more improved effect (column 18, lines 36-39). A multi-phase structure thermoplastic resin according to Yoshitani as a sliding property improving agent effectively improves the property of the resins without adversely affecting the mechanical and physical properties of the thermoplastic resins and the sliding property is improved only by blending under a molten state (column 18, lines 47-53).

(e) Orikasa (USP 5,036,120)

Orikasa discloses a thermoplastic resin composition containing (I) 100 parts by weight of a polyoxymethylene resin alone or a mixture of said polyoxymethylene resin and a polycarbonate resin, with (II) 0.1 to 100 parts by weight of a graft copolymer which is composed of 5 to 95% by weight of an epoxy group-containing olefin copolymer and 95 to 5% by weight of a vinyl polymer or copolymer obtained from at least one kind of vinyl monomer, either or both the components being in the state of a dispersion phase having a particle diameter of 0.001 to 10 μm (claim 1). A flame retardant (IV) may be additionally blended in an amount of 5 to 150 parts by weight based on 100 parts by weight of the thermoplastic resin composition (I)+(II) (claim 8). The polycarbonate resin may be a bisphenol A polycarbonate having a number average molecular weight of 15,000 to 80,000 (claim 12).

In Orikasa, the thermoplastic resin composition can be brought into a flame resistant state by blending therewith a flame retardant (V) in an amount of 5 to 150 parts by weight based on 100 parts by weight of the thermoplastic resin composition (I)+(II) (column 8, lines 44-49). In addition, phosphorus series flame retardants include

phosphates and halogenated phosphates such as tricresyl phosphate, tri(β -chloroethyl)phosphate, tri(-dibromopropyl) phosphate and 2,3 -dibromopropyl- 2, 3-chloropropyl phosphate, phosphonic acid compounds and phosphonic acid derivatives (column 9, lines 6-11). Examples of other flame retardants include guanidine compounds such as guanidine nitride (column 9, lines 12-13).

Orikasa discloses that the thermoplastic resin composition has improved heat resistance, impact resistance, moldability, electrical properties and chemical resistance, and in addition. this composition can be easily manufactured only by mixing raw materials under melting (column 16, lines 50-55).

(f) Gareiss (USP 6,093,759)

Gareiss discloses a flame-retardant thermoplastic molding composition comprising:

- A) from 5 to 99% by weight of a thermoplastic polymer,
- B) from 0.1 to 50% by weight of a phosphazene of the general formula I and
- C) from 0 to 70% by weight of other additives and processing aids.
where the total of the percentages by weight of components A) to C) is 100%, and where component B) (claim 1).

The thermoplastic polymer (A) may be selected from the class consisting of polyesters. polycarbonates. polyamides, polyolefins, polyoxymethylenes, vinylaromatic polymers. polyarylene ethers and poly(meth)acrylates and mixtures of these (claim 2). The composition may contain additives such as reinforcing agents, glass fibers, aromatic polyamide fibers (column 11, lines 18-45).

With respect to the effects, Gareiss discloses that the molding compositions thereof have good processability, and also good flame retardancy, in particular no burning drops (column 12. lines 13-15).

(g) Hilt (3,884,867)

Hilt discloses a self-extinguishing molding composition based on a polyoxymethylene characterized by a content of from 5 to 15% by weight (based on the total weight of the molding composition) of finely divided neutral or basic red phosphorus and by a content of from 1 to 40% by weight (based on the total weight of the molding composition) of glass fibers (claim 1). The red phosphorus may be coated with a solid substance having a melting point of from 500 to 120⁰C, said solid substance being distillable (claim 6). The solid substance may be trioxane or caprolactam (claim 7).

An object of Hilt is to provide polyoxymethylene molding compositions which (a) have valuable mechanical properties and (b) are self-extinguishing (column 1, lines 26-28). Hilt discloses that it is extremely surprising that red phosphorus should make polyoxymethylenes self-extinguishing which, when heated, decompose into gaseous flammable formaldehyde, even in the presence of incorporated glass fibers (column 1, lines 42-47).

(h) Kaiser (USP 3,951,908)

Kaiser discloses a composition comprising a high melting point, synthetic thermoplastic polymer selected from the group consisting of polyamides, linear polyesters and polyacetals and red phosphorus evenly incorporated into said polymer in a concentration ranging from 1 to 75% by weight based on the weight of the polymer, said composition being obtained by melt blending and uniformly incorporating into said polymer at a temperature above about 200⁰C. a lactam-impregnated red phosphorus mixture consisting essentially of from 25 to 90% by weight of particulate red phosphorus and from 10 to 75% by weight of lactam having from 4 to 12 carbon atoms (claim 1). The polymer may be flame-proofed by a content of about 1 to 20% by weight of said red phosphorus (claim 2). The polymer may be a masterbatch with a content of about 20 to 75% by weight of said red phosphorus (claim 3).

An important advantage of the use of a lactam-impregnated red phosphorus is that during or after incorporation of the phosphorus/lactam mixture into a synthetic thermoplastic polymer material the lactam may be completely or partially recovered by distillation (column 2, lines 17-22).

Particularly suitable high melting point thermoplastic polymers are polyamides, polyurethanes, polyacetals and saturated polyesters and polyester amides. and also homopolymers and copolymers of olefinically unsaturated monomers such as styrene/acrylonitrile copolymers or propylene polymers (column 2, lines 44-54).

In addition to the red phosphorus or the lactam-impregnated red phosphorus, the polymers may also contain lubricants and stabilizers, such as substituted phenols. naphthols in the usual concentrations (column 4, lines 7-14).

The use of the lactam/red phosphorus mixtures of the invention enables thermoplastic compositions having excellent flame-retardant properties to be particularly efficiently produced without any technical difficulties (column 4, lines 25-28).

(i) Cerny (USP 4,424,240)

Cerny discloses compositions intended for the flameproofing of plastics, which do not evolve toxic products during the processing of these plastics, characterized in that they contain:

- (1) from 50 to 95% by weight of red phosphorus in the form of a powder having a mean particle size of less than 200 μ ;
- (2) from 5 to 50% by weight of a thermoplastic phenol-formaldehyde polycondensate of molecular weight between 120 and 1,500, wherein the molar ratio of formaldehyde to phenol is between 0.7 and 0.9 and in which the particles of red phosphorus are coated with the polycondensate (claim 1).

The polycondensates can also be deposited on the surface of the phosphorus particles (column 2, lines 26-27).

In order that the protection provided by the polycondensate to be satisfactory, the amount used must be between 5 and 50% by weight relative to the red phosphorus (column 2, lines 42-45). It is known, furthermore, that the addition of metal oxides or metal salts stabilizes the red phosphorus; the red phosphorus sold commercially usually contains these additives (column 2, lines 46-49).

Numerous synthetic polymers are used to obtain shaped articles which more and more frequently must be flameproofed (column 2, lines 62-64). Amongst the thermoplastic polymers there may be mentioned; polyolefins, polyvinyl compounds, polystyrenes and acrylonitrile-butadiene-styrene copolymers, polyamides, saturated polyesters, polyacetals and polyacrylics, cellulosic esters, polyurethanes or polyamide-imides (column 2, line 67 to column 3, line 18).

In the examples, the polymer to be flameproofed which was chosen, was a polyamide 6,6, the moisture absorption of which is, with the exception of the cellulose, amongst the highest exhibited by polymers and, under the action of heat and in the presence of red phosphorus, leads to the greatest evolutions of phosphine (column 3, lines 45-52).

The use of encapsulated red phosphorus particles offers numerous advantages amongst which there may be mentioned the ease of handling before and during introduction into the polymer compositions, the reduction of pollution hazards during the preparation of the compounds, and above all the absence of evolution of phosphine during processing, principally when working at temperatures above 200°C. (column 3, lines 37-44).

(j) Yamauchi (USP 5,965,639)

Yamauchi discloses a flame retardant resin composition comprising 100 parts by weight of a thermoplastic resin consisting of the following structural components (I), (II), (III) and (IV) and 0.1 to 10 parts by weight of red phosphorus (C), said red phosphorus is covered with a thermosetting resin (claim 1). The composition may further comprise a hindered phenol based stabilizer (claim 11) and a salt formed by a triazine based compound and a cyanuric acid or isocyanuric acid (claim 12).

The flame retardant resin composition of Yamauchi comprises 100 parts by weight of the following component (A) or (B) and 0.01 to 30 parts by weight of red phosphorus (C):

(A) (a1) 67 to 99.99 wt% (based on the total weight of (a1) and (a2)) of a thermoplastic resin other than polyethylene terephthalate and ethylene terephthalate and/or an ethylene terephthalate and/or an ethylene terephthalate copolymer, and

(B) a thermoplastic resin consisting of the structural components (I), (II), (III) and (IV) (column 5, lines 1-15).

The thermoplastic resin (a1) that can be used include, those of formulas (I) to (IV) (column 12, line 66 to column 13, line 4).

Red phosphorus for this purpose can be treated, for example, by mixing red phosphorus with E-caprolactam or trioxane, to stabilize it, covering red phosphorus with a phenol based thermosetting resin, to stabilize it. (column 13, line 28-40). The average grain size of the red phosphorus used in the present invention is preferably 0.01 to 50 μm (column 14, lines 1-2).

The amount of the hindered phenol based oxidation stabilizer added is usually 0.01 to 3 parts by weight against 100 parts by weight of the thermoplastic resin (a1) or the thermoplastic resin (B) (column 14, lines 41-49).

If a salt formed by a triazine based compound and a cyanuric acid or isocyanuric acid is added further to the flame retardant resin composition of the present invention, the flame retardancy can be further enhanced (column 16, lines 53-56).

The amount of the salt used is usually 0.01 to 40 parts by weight against 100 parts by weight of the thermoplastic resin (a1) or the thermoplastic resin (B) (column 18, lines 13-18).

When the additives used as desired are added when the resin composition (D) higher in red phosphorus content than the red phosphorus content to be achieved in the intended flame retardant resin composition is produced, it is preferable to mix the additives used as desired, with red phosphorus beforehand (column 19, lines 10-15).

The resin composition (D) higher in red phosphorus can be preferably used as so-called master pellets (column 19, lines 25-26).

The thermoplastic resin (a1) or the thermoplastic resin (B) to be mixed with the resin composition (D) higher in red phosphorus content can be preferably pellets (column 19, lines 29-34).

(k) Imahashi (USP 6,130,282)

Imahashi discloses a flame retardant resin composition which consists essentially of

- (A) 100 parts by weight of a synthetic resin;
- (B) 20 to 150 parts by weight of magnesium hydroxide particles; and
- (C) 20 to 150 parts by weight of aluminum hydroxide particles (claim 1).

The flame retardant resin composition may contain at least one retardant aid selected from the group consisting of red phosphorus powder, silicone and carbon powder in an amount of 0.1 to 30 parts by weight based on 100 parts by weight of the synthetic resin (claim 11).

Imahashi discloses on column 6, lines 30-36 that the red phosphorus powder is preferably stabilized red phosphorus powder which rarely generates phosphine gas at the time of kneading, molding or heating. Illustrative examples of the stabilized red phosphorus powder include thermoplastic resin-coated red phosphorus, titan and aluminum condensate coated red phosphorus and the like.

These flame retardant aids are preferably used in an amount of 0.1 to 30 parts by weight, based on 100 parts by weight of the synthetic resin (column 6. lines 43-46). The synthetic resin may be olefin (α -olefin) polymers and copolymers, the copolymers of these olefins and diene, ethylene-acrylate copolymers. and thermoplastic resins such as polystyrene, ABS resin, MS resin, AS resin, MBS resin. TPO resin, ethylene-vinyl acetate polymer resin, vinyl acetate resin, phenoxy resin, polyacetal, polyamide and methacrylic resin (column 6. lines 47-59).

(2) Patentability of the Present Invention Over the Applied References

Applicants note that none of the cited references disclose or suggest the combined use of a phosphorus-containing compound with an aromatic compound in relation to a polyacetal resin (POM) in the specific proportion claimed herein. Specifically, the cited references fail to disclose or suggest an important role of the above-noted combined use for flame retardation of POM. Thus, the combination of all elements of the present invention is patentably different from the references.

Specifically, except for the cited Cerney reference, all other references are completely silent on not only the specific proportion of the phosphorus-containing compound relative to the aromatic compound but also the meanings thereof. Although Cerny discloses the above proportion of the phosphorus-containing compound relative to the aromatic compound, Cerney does not disclose or suggest anything about the total amount of the phosphorus-containing compound and aromatic compound relative to the

POM and the meanings thereof. Thus, the above-noted combined use in relation to POM and the important role thereof would never be predicted from the cited references.

Further, the present invention shows unexpected results. That is, since Amann, Abolins, Doyama, Yoshitani, Orikasa, Gareiss, Hilt, Kaiser, Yamauchi, and Imashi fail to disclose or suggest the meanings of the above combined use and Cerny is silent on the meanings of the above total amount relative to the POM, it would never be predicted how flame retardation of the POM composition could be improved.

To the contrary, according to the present invention, the above combinational use effectively makes the POM flame-retardant. Specifically, the aromatic compound accelerates carbonization of the POM and improves flame retardancy of the POM in association with the phosphorus-containing compound. High flame retardancy of the POM composition would be achieved by the above combination. For example, comparing the Examples 25-40 and 43-46 with the Comparative Examples 11-27 lacking the phosphorus-containing compound, both flame retardancy and glowing are improved from C (non-self-extinguishable shaped article burned to the clamped part with no glowing time observed) to A (self-extinguishable shaped article with each of a combustion time and a glowing time of 10 sec. or shorter) by the Examples. Moreover, although flame retardant was dripped from the articles in the Comparative Examples but never dripped in the Examples. When the Examples 47-51 are compared with the Comparative Examples 31-33 lacking the aromatic compound, similar results are obtained. These results could never have been predicted from the cited references.

Withdrawal of all art-based rejections of record is therefore in order.

HARASHINA
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II. Conclusions

Every effort has been made to advance prosecution of this application to allowance. Therefore, in view of the amendments and remarks presented herewith, applicants suggest that this application is in condition for allowance and Official Notice to that effect is solicited.

Respectfully submitted,

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